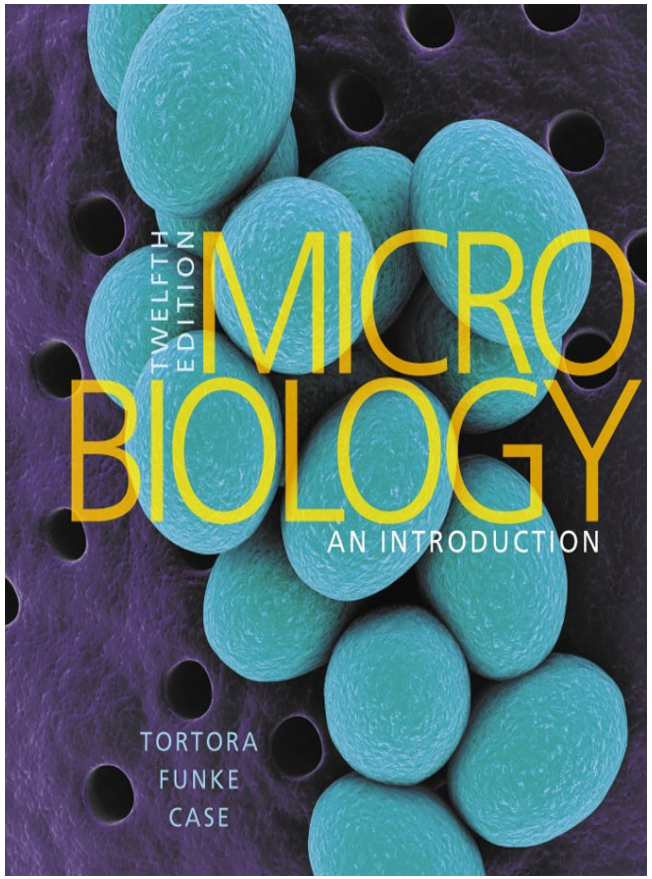
Microbiology an Introduction

Twelfth Edition

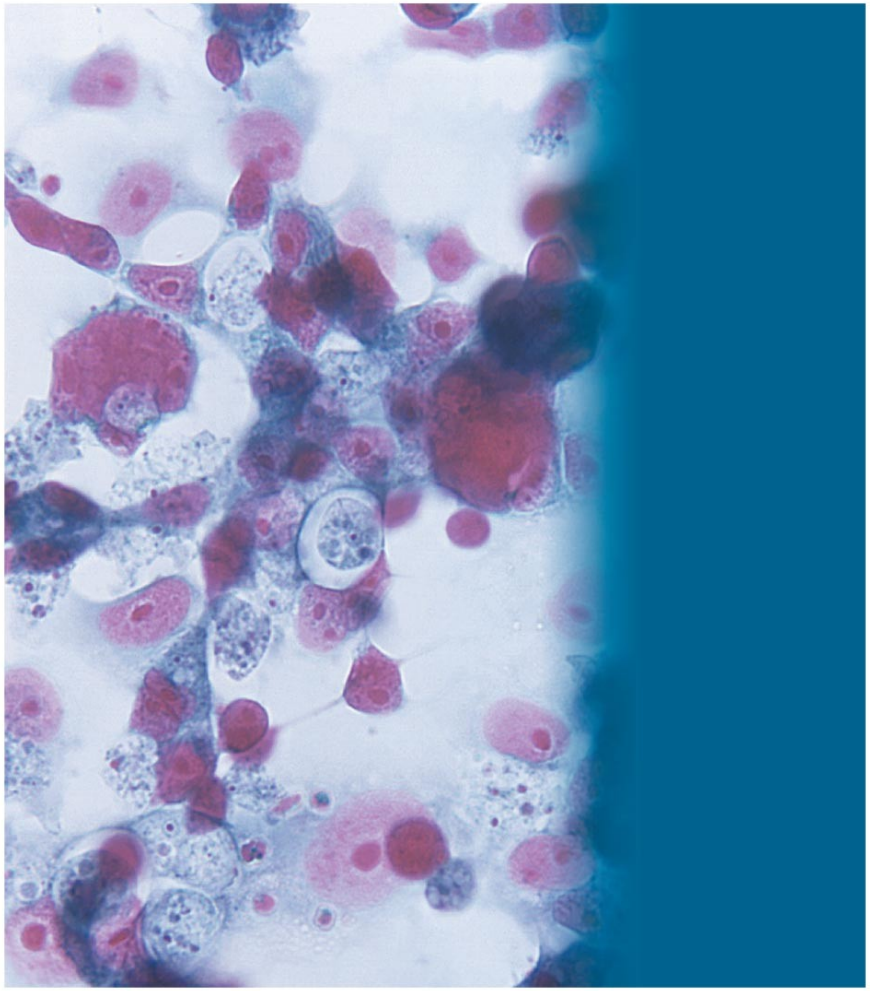


Chapter 22

Microbial Diseases of the Nervous System

Pearson

Naegleria Ameba (Red)



Structure and Function of the Nervous System (1 of 3)

Learning Objectives

22-1 Define **central nervous system** and **blood–brain barrier**.

22-2 Differentiate meningitis from encephalitis.

Structure and Function of the Nervous System (2 of 3)

- **Central nervous system (CNS):** brain and spinal cord
- **Peripheral nervous system (PNS):** nerves that branch from the CNS
- Meninges protect the brain and spinal cord
  - Dura, arachnoid and pia mater: outer, middle and innermost layers, respectively
    - Subarachnoid space contains **cerebrospinal fluid (CSF)**
- **Blood–brain barrier**

Figure 22.1 The Human Nervous System

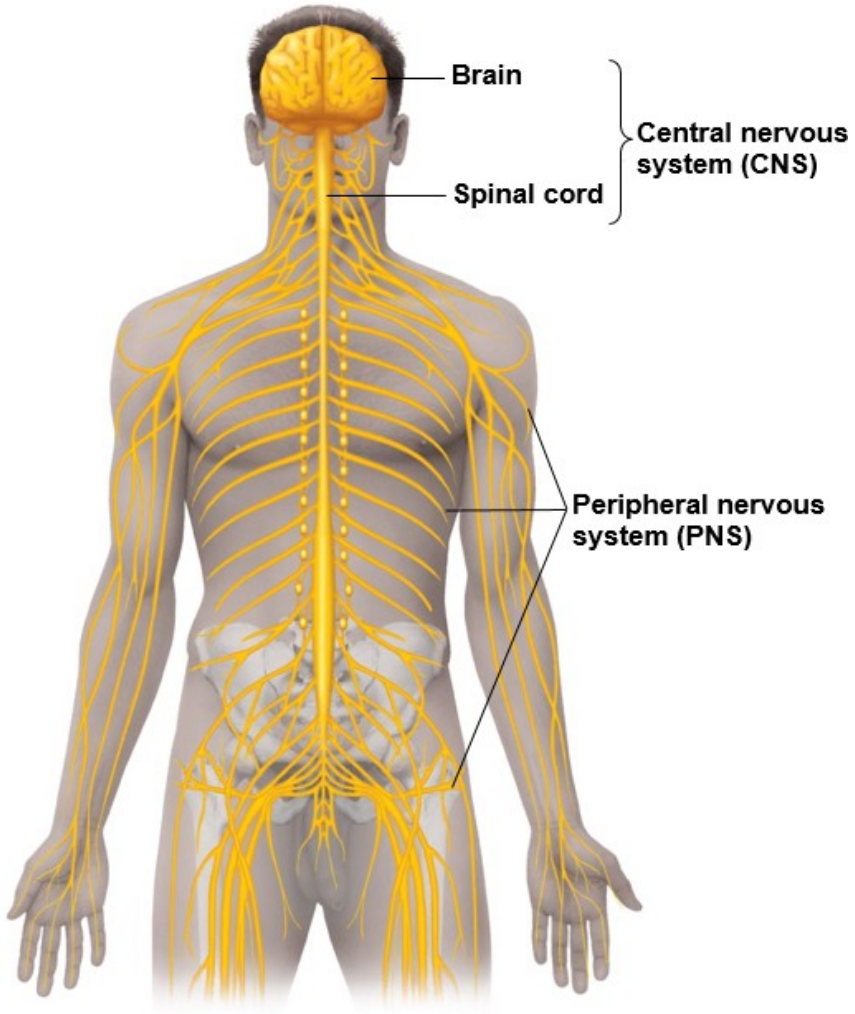


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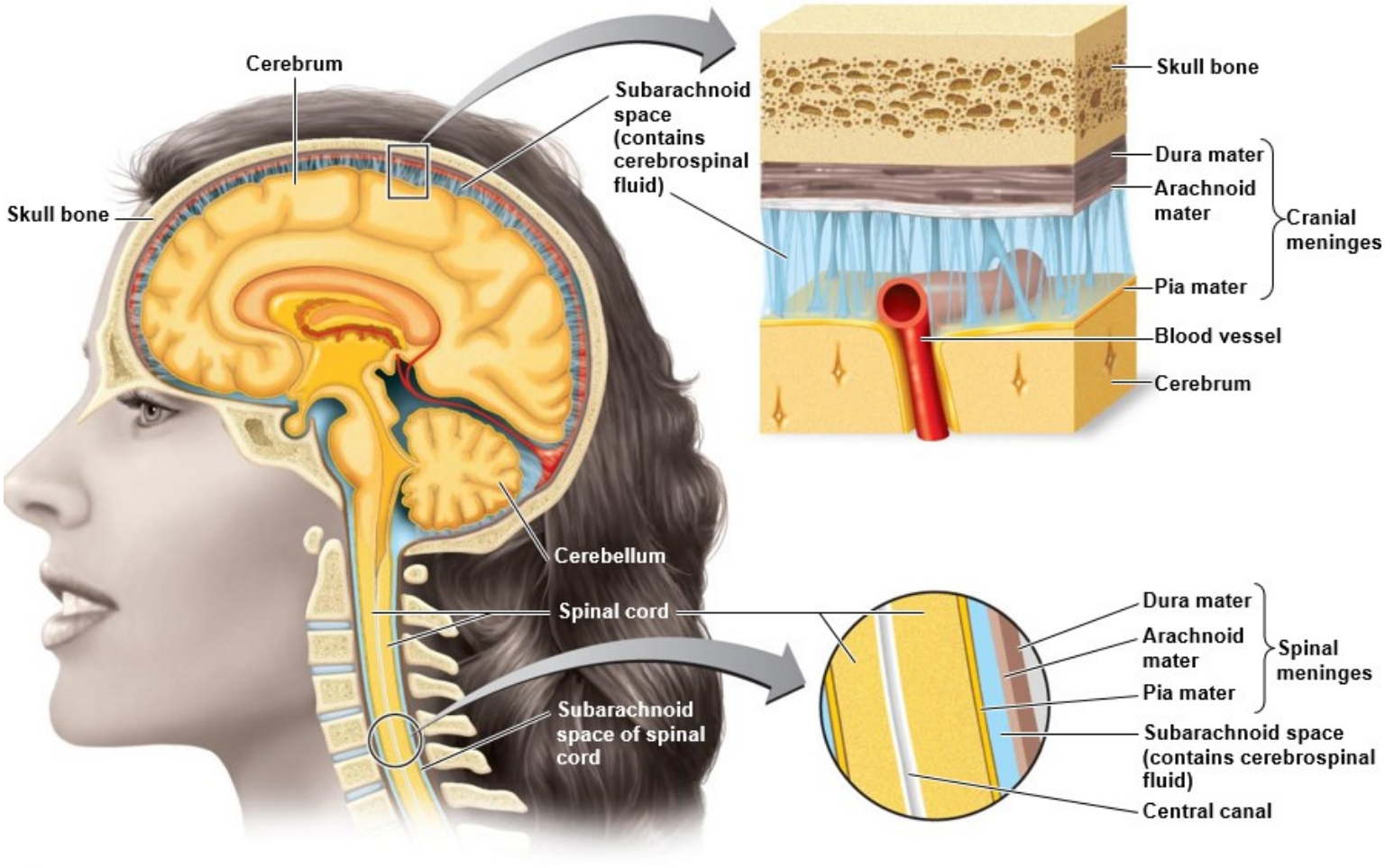
Figure 22.2 The Meninges and Cerebrospinal Fluid



Structure and Function of the Nervous System (3 of 3)

- **Meningitis:** inflammation of the meninges
- **Encephalitis:** inflammation of the brain
- **Meningoencephalitis:** inflammation of both

Check Your Understanding-1

Check Your Understanding

- ✓ Why can the antibiotic chloramphenicol readily cross the blood–brain barrier, whereas most other antibiotics cannot?
  22-1
- ✓ Encephalitis is an inflammation of what organ or organ structure?
  22-2

Bacterial Diseases of the Nervous System (1 of 2)

Learning Objectives

22-3 Discuss the epidemiology of meningitis caused by **Haemophilus influenzae, Neisseria meningitidis, Streptococcus pneumoniae**, and **Listeria monocytogenes**.

22-4 Explain how bacterial meningitis is diagnosed and treated.

Bacterial Diseases of the Nervous System (2 of 2)

Learning Objectives

22-5 Discuss the epidemiology of tetanus, including mode of transmission, etiology, disease symptoms, and preventive measures.

22-6 State the causative agent, symptoms, suspect foods, and treatment for botulism.

22-7 Discuss the epidemiology of leprosy, including mode of transmission, etiology, disease symptoms, and preventive measures.

Bacterial Meningitis

- Initial symptoms of fever, headache, and a stiff neck
- Followed by nausea and vomiting
- May progress to convulsions and coma
- Death from shock and inflammation
  - Due to endotoxin and cell wall release
- **Viral meningitis** is more common and mild

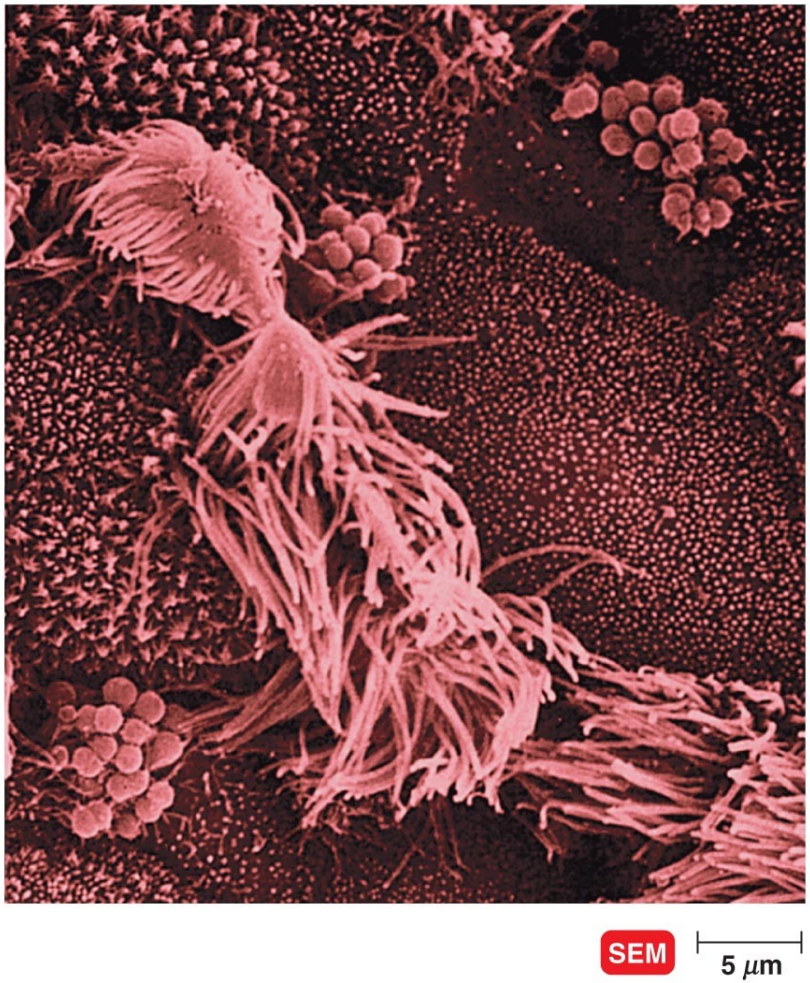
Haemophilus Influenzae Meningitis

- Gram-negative aerobic bacteria; normal throat microbiota
- Can enter the bloodstream
- Pathogenicity due to capsule antigen type b
- Occurs mostly in children (6 months to 4 years)
- Prevented by the Hib vaccine
- Accounts for 45% of bacterial meningitis cases; 6% mortality

Neisseria Meningitidis Meningitis (Meningococcal Meningitis) (1 of 2)

- Gram-negative aerobic cocci with a capsule
  - Six serotypes associated with the disease
- Forty percent of people are healthy nasopharyngeal carriers
- Begins as a throat infection, rash, and bacteremia
- Mortality of 9–12% with antibiotic therapy; 80% without
- Outbreaks common in dorms and military barracks
- Vaccination protects against serogroups A, C, Y, and W, but not B

Figure 22.3 Neisseria Meningitis



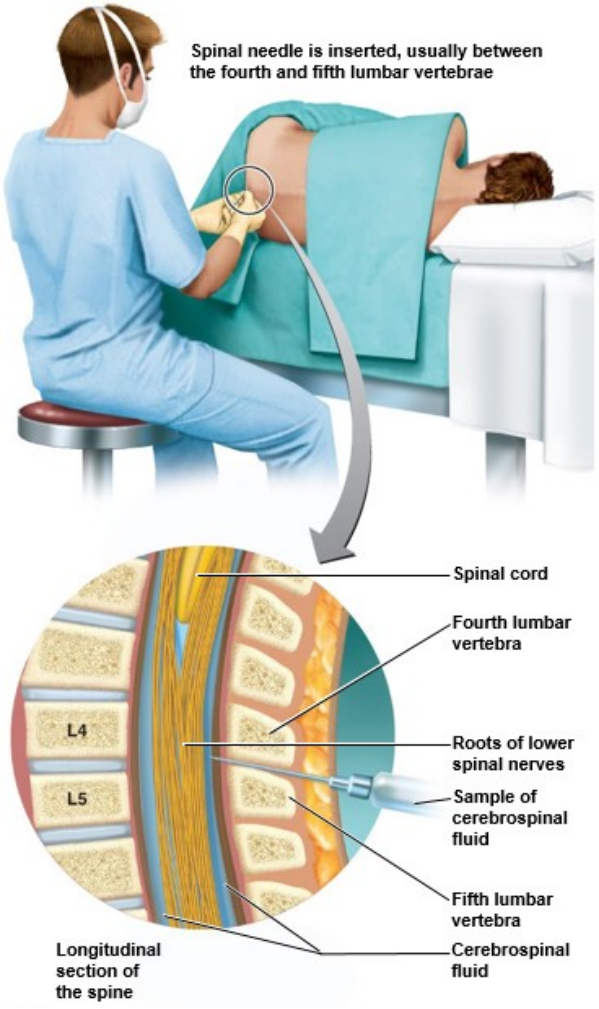
Neisseria Meningitidis Meningitis (Meningococcal Meningitis) (2 of 2)

- Gram-positive encapsulated diplococcus
- Seventy percent of people are healthy nasopharyngeal carriers
- Also causes pneumonia and otitis media
- Most common in children (1 month to 4 years)
- Mortality: 30% in children, 80% in the elderly
- Prevented by conjugated vaccine

Diagnosis and Treatment of the Most Common Types of Bacterial Meningitis

- Sample CSF via a spinal tap or lumbar puncture
  - Pathogens in CSF do not survive storage or changes in temperature
- Latex agglutination tests
- Chemotherapy initiated before diagnosis
  - Broad spectrum third-generation cephalosporins

Figure 22.4 Spinal Tap (Lumbar Puncture)



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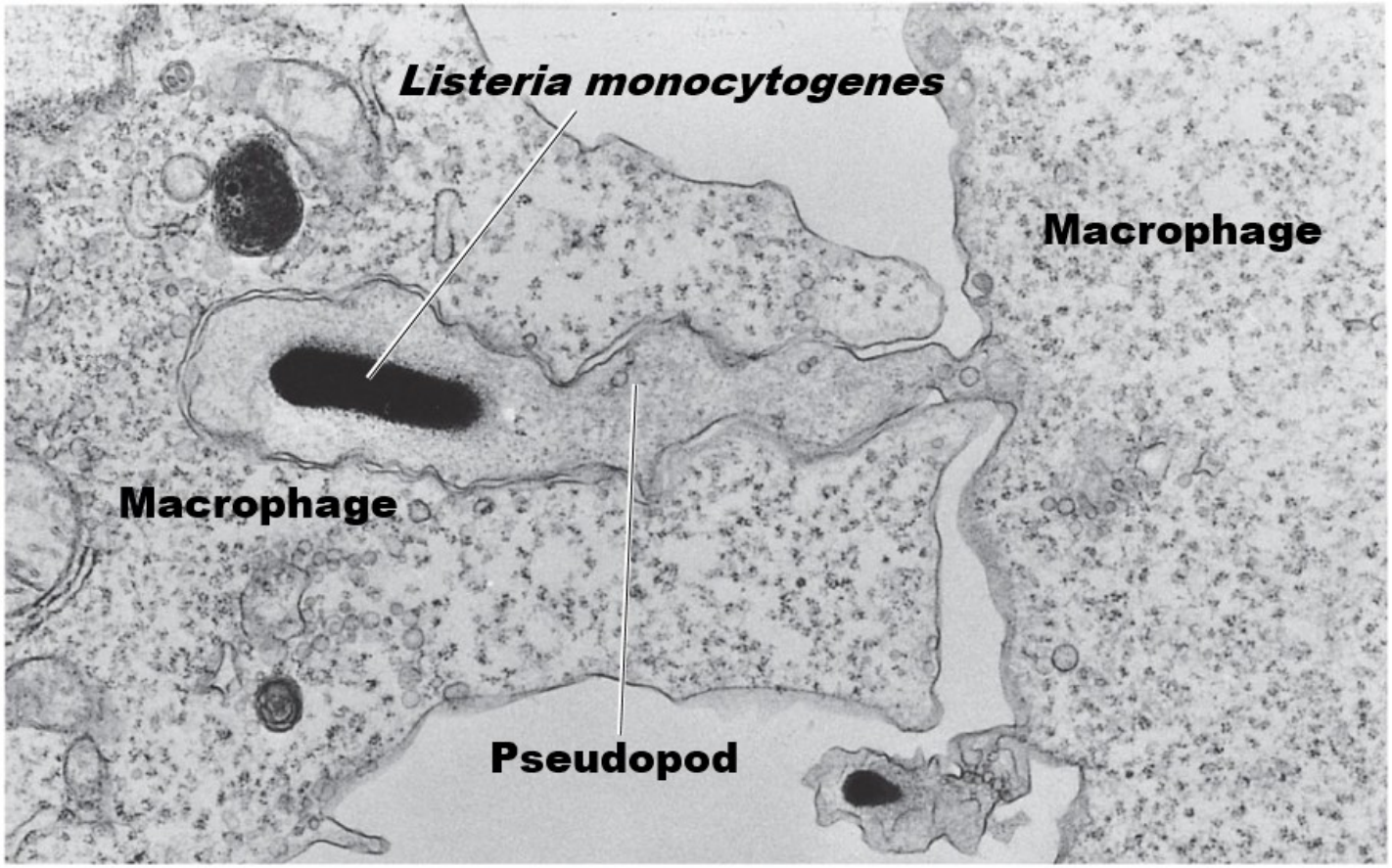
Listeriosis

- Caused by **Listeria monocytogenes**
  - Gram-negative aerobic rod
- Usually foodborne and asymptomatic
  - Meningitis more common in the immunocompromised
- Can invade the bloodstream, causing sepsis
- Reproduces in phagocytes
  - Spread phagocyte-to-phagocyte
- Infects pregnant women, crossing the placenta and leading to stillbirth

Figure 22.5 Cell-to-Cell Spread of Listeria Monocytogenes, the Cause of Listeriosis



Check Your Understanding-2

Check Your Understanding

- ✓ Why is meningitis caused by the pathogen **Listeria monocytogenes** frequently associated with ingestion of refrigerated foods?
  22-3
- ✓ What body fluid is sampled to diagnose bacterial meningitis?
  22-4

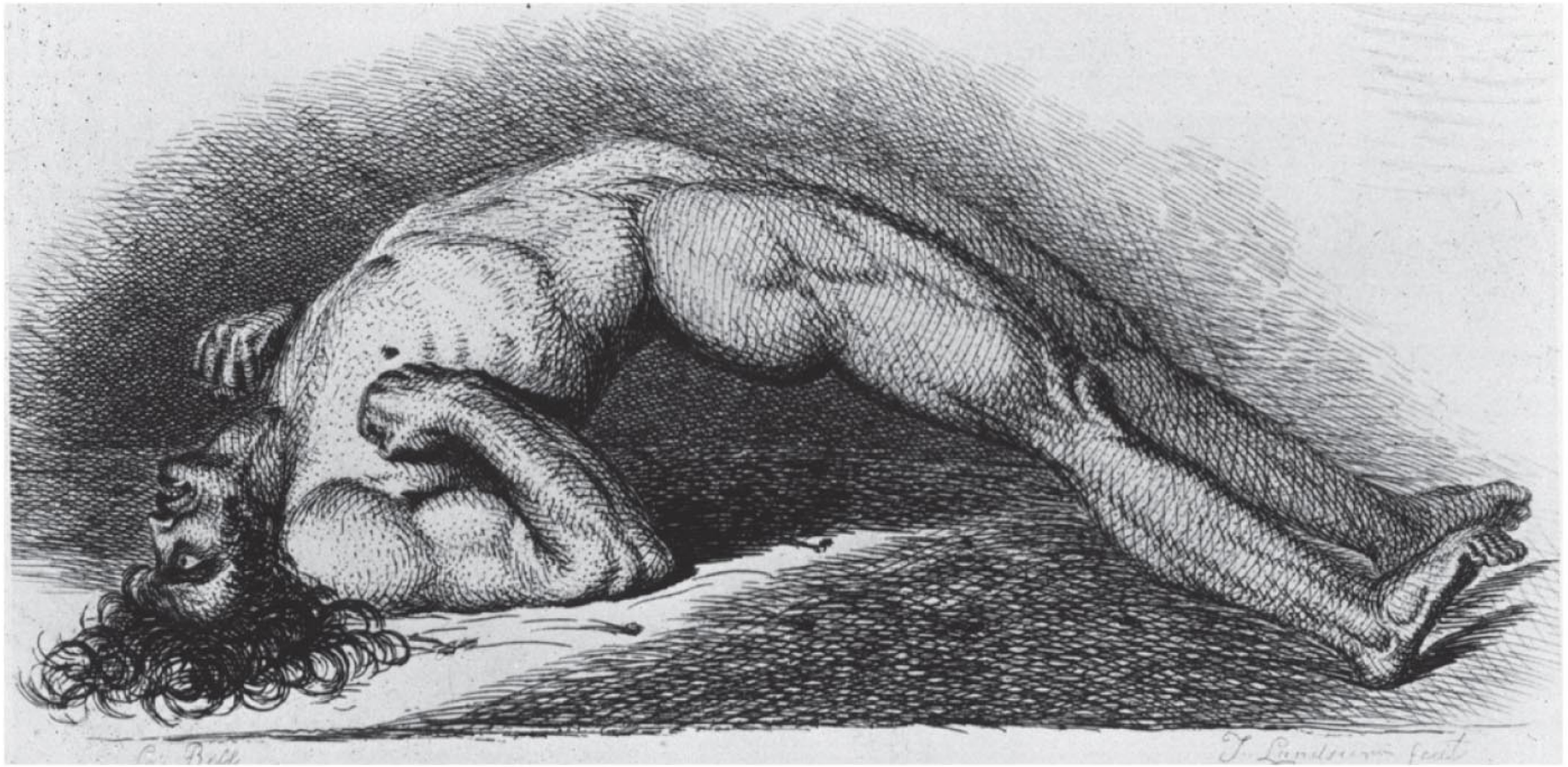
Tetanus (1 of 2)

- Caused by **Clostridium tetani**
  - Gram-positive, endospore-forming, obligate anaerobe
- Grows in deep wounds with anaerobic conditions
- **Tetanospasmin** released from dead cells
  - Enters CNS
  - Blocks the relaxation pathway in muscles, causing muscle spasms
    - Death occurs from spasms of respiratory muscles

Tetanus (2 of 2)

- Prevented by vaccination with a tetanus toxoid (DTaP)
  - Stimulates antibodies that neutralize the toxin
  - Booster required every 10 years
- Fewer than 50 cases per year
  - Mortality of 25–50%
- Treatment with tetanus immune globulin (TIG)
- Infected tissue removed via **debridement**

Figure 22.6 An Advanced Case of Tetanus



Check Your Understanding-3

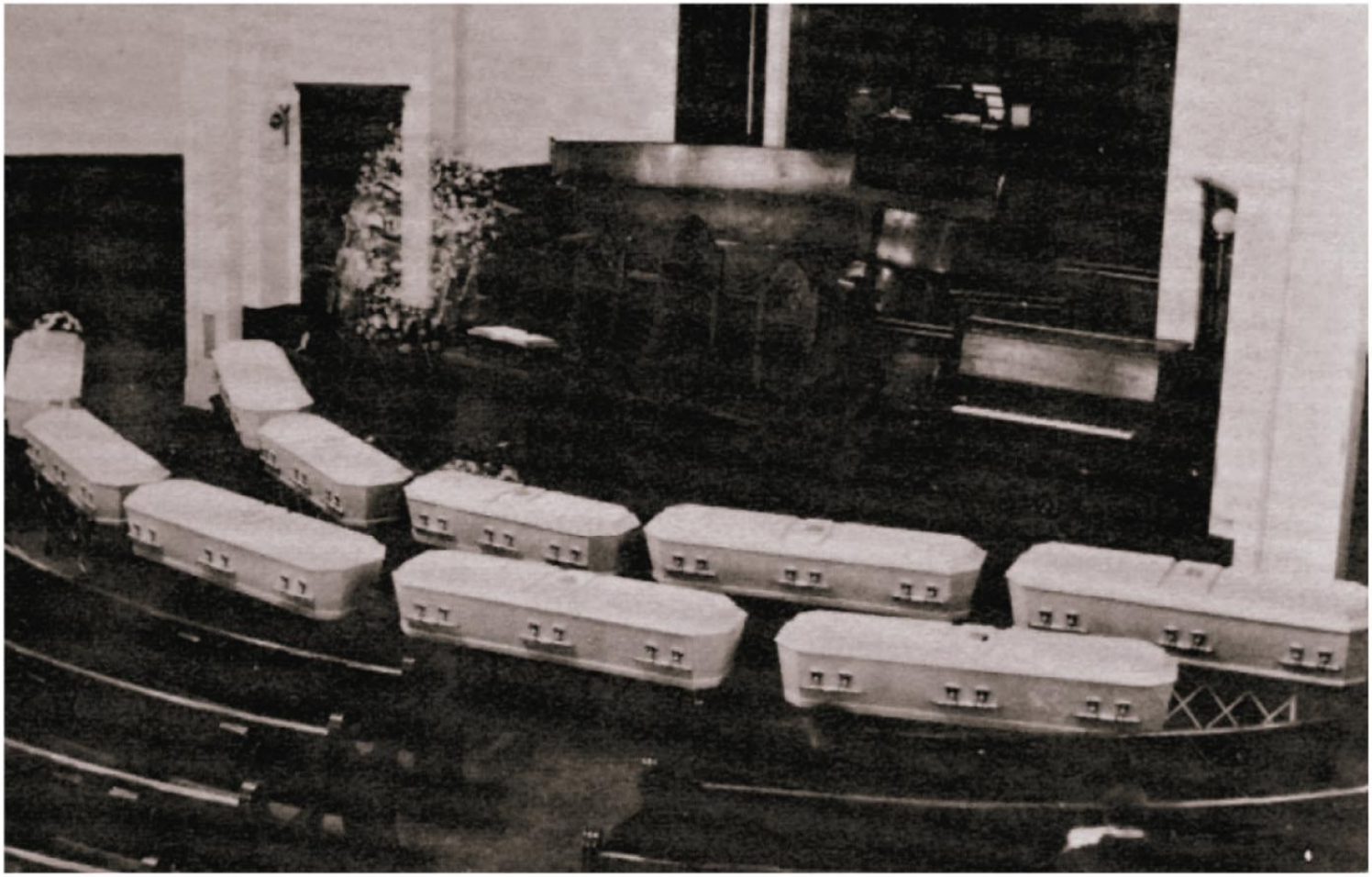
Check Your Understanding

- ✓ Is the tetanus vaccine directed at the bacterium or the toxin produced by the bacterium?
  22-5

Botulism

- Caused by **Clostridium botulinum**
  - Gram-positive, endospore-forming, obligate anaerobe
- Intoxication comes from ingesting the botulinal exotoxin
  - Specific for the synaptic end of the nerve
  - Blocks release of the neurotransmitter acetylcholine, causing flaccid paralysis
- Death usually comes from respiratory or cardiac failure

Figure 22.7 Funeral of an Oregon Family Wiped out by Botulism in 1924



Botulinal Types

- Type A toxin
  - Fatality: 60–70%
  - Heat-resistant and proteolytic
- Type B toxin
  - Fatality: 25%
- Type E toxin
  - Produced by organisms in marine and lake sediments
  - Less heat-resistant than other strains
- Diagnosed by inoculating immunized mice with patient samples

Figure 22.8 Diagnosing Botulism by Identifying Botulinal Toxin Type

Incidence and Treatment of Botulism

- **Infant botulism: C. botulinum** growing in the intestines of infants due to a lack of intestinal microbiota
  - Associated with honey
- **Wound botulism:** growth of **C. botulinum** in wounds
- Treatment with respiratory assistance and antitoxins
- Prevented with proper canning and the use of nitrites in foods

Check Your Understanding-4

Check Your Understanding

- The very name **botulism** is derived from the fact that sausage was the most common food causing the disease. Why is sausage now rarely a cause of botulism?
  22-6

Diseases in Focus: Meningitis and Encephalitis

- A worker in a day-care center in eastern North Dakota becomes ill with fever, rash, headache, and abdominal pain. The patient has a precipitous clinical decline and dies on the first day of hospitalization. Diagnosis is confirmed by Gram staining of cerebrospinal fluid.
- Can you identify infections that could cause these symptoms?

Diseases in Focus 22.3 (1 of 5)

Diseases in Focus 22.3 (2 of 5)

Disease	Pathogen	Symptoms	Method of Transmission	Treatment	Prevention
BACTERIAL DISEASES					
Tetanus	**Clostridium tetani**	Lockjaw; muscle spasms	Puncture wound	Tetanus immune globulin; antibiotics	Toxoid vaccine (DTaP, Td)
Botulism	**Clostridium botulinum**	Flaccid paralysis	Foodborne intoxication	Antitoxin	Proper canning of foods; infants should not eat honey
Leprosy	**Mycobacterium leprae, M. lepromatosis**	Loss of sensation in skin; disfiguring nodules	Prolonged contact with contaminated secretions	Dapsone, rifampin, clofaximine	Possibly BCG vaccine
VIRAL DISEASES					
Poliomyelitis	Poliovirus	Headache, sore throat, stiff neck; paralysis if motor nerves infected	Ingesting Contaminated water (fecal–oral route)	Ingesting contaminated water (fecal–oral route)	Inactivated polio vaccine (IPV)
Rabies	**Lyssavirus**	Fatal infection; agitation,	Animal bite	Postexposure treatment: rabies	Human diploid cell vaccine for high-

Leprosy (1 of 2)

- Also called **Hansen's disease**
- Caused by **Mycobacterium leprae**
  - Acid-fast rod that grows best at 30°C
  - Generation time of 12 days
  - Grows in peripheral nerves and skin cells
    - Survives macrophages and invades the myelin sheath
- Transmission requires prolonged contact with an infected person or the inhalation of secretions

Leprosy (2 of 2)

- Tuberculoid (neural) form: loss of sensation in skin areas
- Lepromatous (progressive) form: disfiguring nodules over the body; mucous membranes are affected
- Cases increasing due to infected immigrants from endemic countries
- Diagnosed with a skin biopsy or skin smear
- Treatment with antibiotics (Dapsone or Rifampin) for 6 to 24 months

Figure 22.9 Leprosy Lesions

(a) Tuberculoid (neural) leprosy

(b) Lepromatous (progressive) leprosy

Check Your Understanding-5

Check Your Understanding

- ✓ Why are nude mice and armadillos important in the study of leprosy?
  22-7

Viral Diseases of the Nervous System

Learning Objectives

22-8 Discuss the epidemiology of poliomyelitis, rabies, and arboviral encephalitis, including mode of transmission, etiology, and disease symptoms.

22-9 Compare the Salk and Sabin polio vaccines.

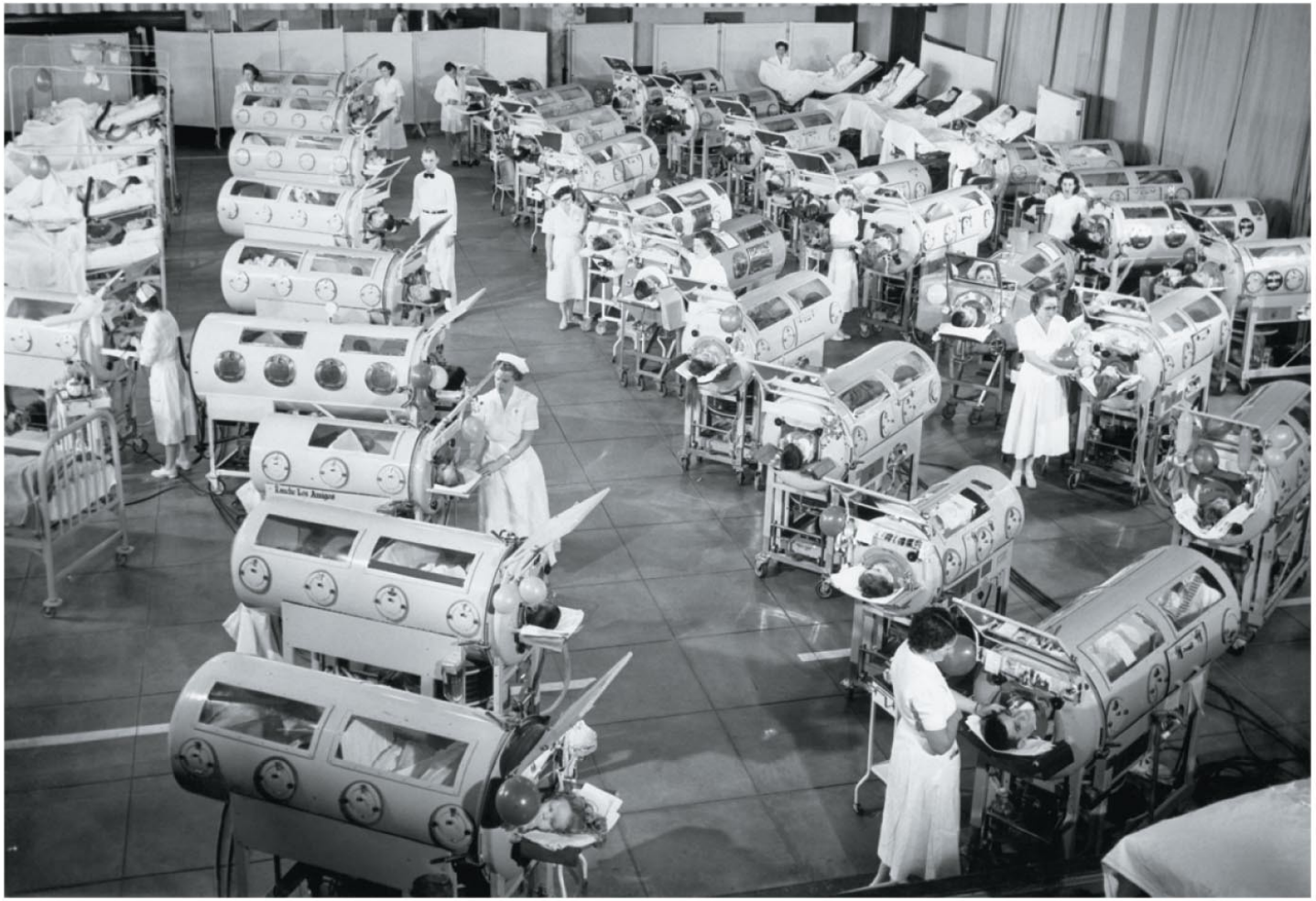
22-10 Compare the preexposure and postexposure treatments for rabies.

22-11 Explain how arboviral encephalitis can be prevented.

Poliomyelitis (1 of 2)

- Caused by the poliovirus
- Transmitted by the ingestion of water containing feces containing the virus
- Initial symptoms: sore throat and nausea
- Viremia may occur; enters the CNS
  - One percent of cases become paralytic
  - Destruction of motor cells
  - Death from respiratory failure
- Postpolio syndrome: muscle weakness occurring decades after infection

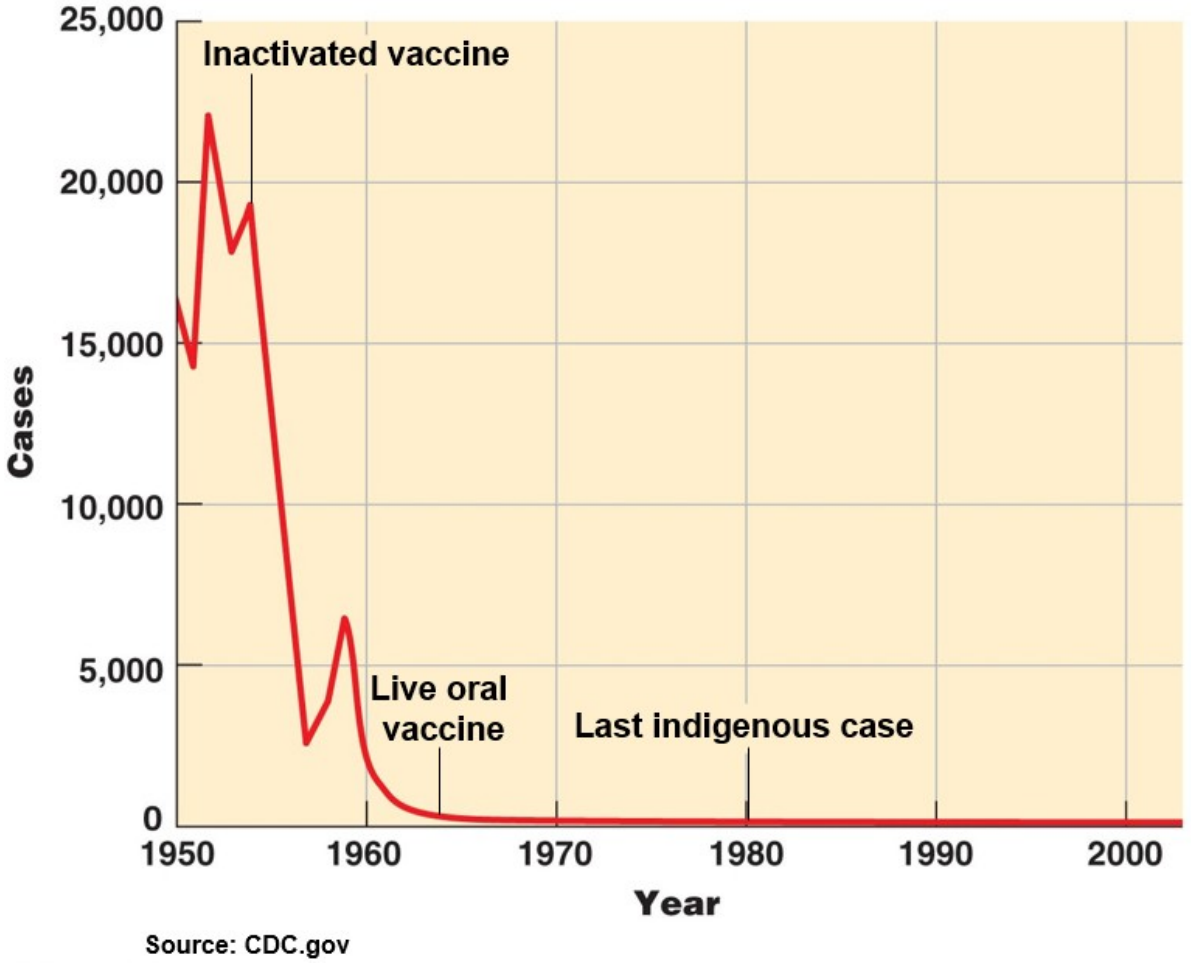
Figure 22.10 Polio Patients in Iron Lungs



Poliomyelitis (2 of 2)

- Vaccine for all three serotypes
  - Salk vaccine: inactivated vaccine; injectable
  - Sabin vaccine: attenuated vaccine; oral; lifelong immunity
- Polio cases fell 99% from 1988 to 2000
- Persistent reservoirs of polio remain in Pakistan, India, Afganistan, and Nigeria

Figure 22.11 U.S. Annual Incidence of Poliomyelitis



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Check Your Understanding-6

Check Your Understanding

- ✓ Why is paralytic polio more likely to occur than a mild or asymptomatic infection in areas with high standards of sanitation?
  22-8
- ✓ Why is the Sabin oral polio vaccine more effective than the injected Salk polio vaccine?
  22-9

Rabies (1 of 4)

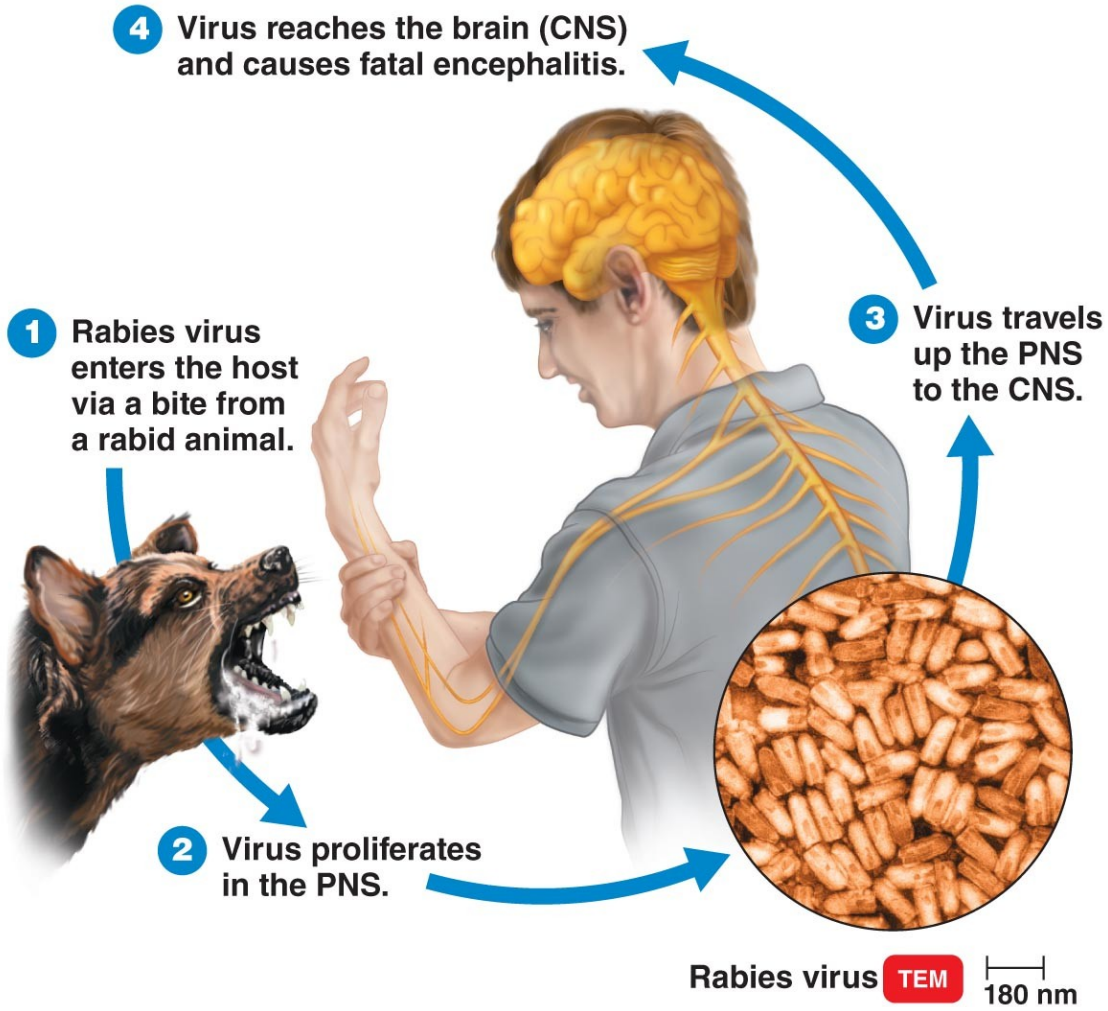
- Caused by the rabies virus
  - Genus **Lyssavirus;** bullet shape
  - Single-stranded RNA; easily develops mutants
- Usually transmitted by the saliva of an animal bite
  - Can also cross mucous membranes
- In the United States, silver-haired bats are the most common cause

Clinical Focus 22.1b

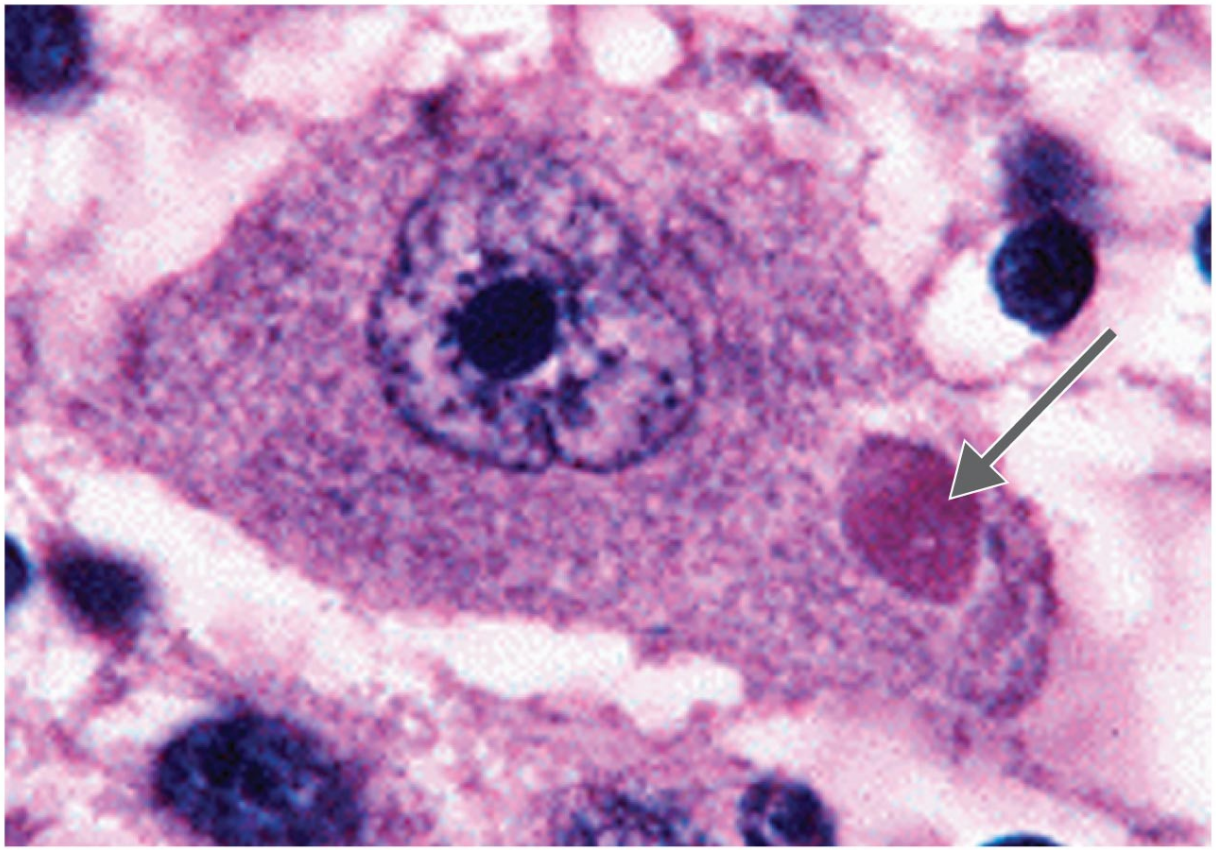
Rabies (2 of 4)

- Initial symptoms: muscle spasms of the mouth and pharynx; hydrophobia
- Virus multiplies in the skeletal muscles and travels through the PNS to the brain cells, causing encephalitis
  - Average incubation of 30 to 50 days
  - Forms Negri bodies in the brain stem
- **Furious (classical) rabies:** animals are restless, then highly excitable
- **Paralytic (dumb** or **numb) rabies:** animals seem unaware of their surroundings; minimally excitable

Figure 22.12 Pathology of Rabies Infection



Clinical Focus 22.1a



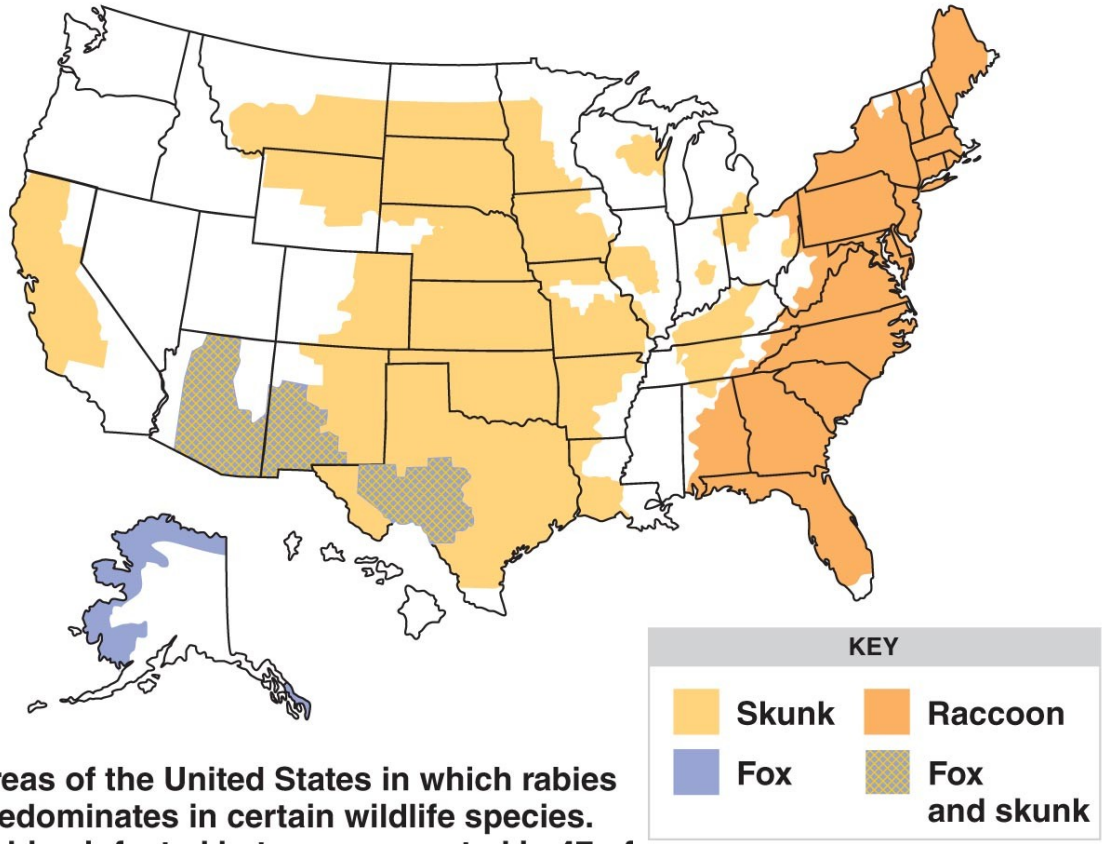
Rabies (3 of 4)

- Diagnosed from bodily fluids with the **direct fluorescent-antibody (DFA) test**
- **Postexposure prophylaxis (PEP):** vaccine plus immune globulin
  - **Human diploid cell vaccine (HDCV)**
  - **Human rabies immune globulin (RIG)**
- Very little effective treatment

Rabies (4 of 4)

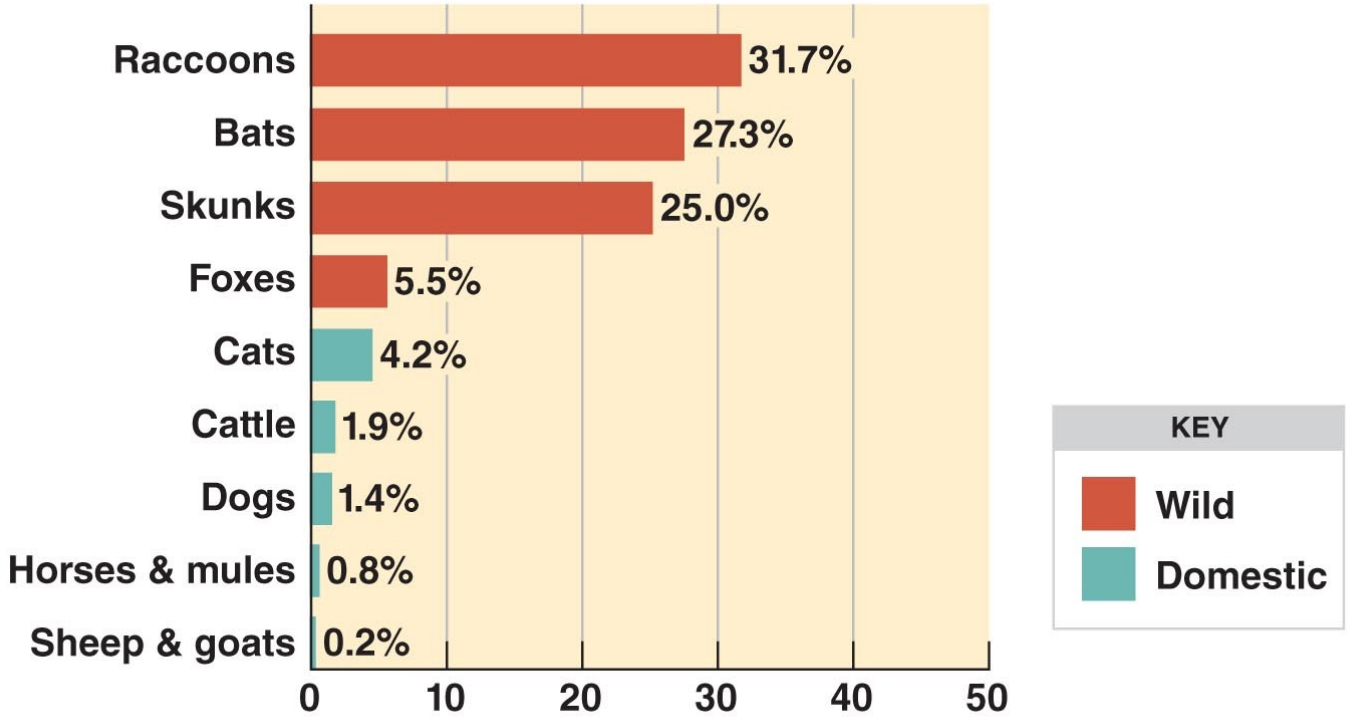
- Global distribution
- In the United States, it occurs in bats, skunks, foxes, raccoons, and domestic animals
  - Rarely in squirrels, rabbits, rats, and mice
- 7000 to 8000 animal cases of rabies in the United States annually
- One to six human cases in the United States annually

Figure 22.13 Reported Cases of Rabies in Animals (1 of 2)



Areas of the United States in which rabies predominates in certain wildlife species. Rabies-infected bats were reported in 47 of the 48 contiguous states. In eastern states in which raccoons are the predominant rabies-infected animal, many cases were also reported in foxes and skunks.

Figure 22.13 Reported Cases of Rabies in Animals (2 of 2)



Rabies cases in various wild and domestic animals in the United States. Rabies in domestic animals such as dogs and cats is uncommon because of high vaccination rates. Raccoons, skunks, and bats are the animals most likely to be infected with rabies. Most human cases are caused by bat bites. Worldwide, most human cases are caused by dog bites.

Lyssavirus Encephalitis

- Clinically indistinguishable from rabies
- Found in countries free of rabies
- Australian bat lyssavirus (ABLV)
- European bat lyssavirus (EBLV)

Check Your Understanding-7

Check Your Understanding

- ✓ Why is postexposure vaccination for rabies a practical option?
  22-10

Big Picture: Neglected Tropical Diseases (1 of 2)

- Sixteen diseases contracted by 1 billion people per year
  - Half a million deaths
  - Disproportionally affect the poor
- Cause various maladies: blindness, disfigurement, liver or lung disease, movement-related disabilities, malnutrition, malaise, cognitive impairment, and neurological damage

Big Picture pg. 622 (1 of 2)

Infection Type	Disease	Management Strategies
PROTOZOAN		
	African trypanosomiasis	Vector (tsetse fly) control, preventive chemotherapy, intensified disease management, veterinary public health
	Chagas' disease	Vector (triatoma) control, intensified disease management
	Leishmaniasis	Vector (sandfly) control, preventive chemotherapy, intensified disease management
HELMINTHIC		
	Cysticercosis	Veterinary public health, improved sanitation and hygiene
	Dracunculiasis (Guinea worm disease)	Vector (copepods) control, improved hygiene and sanitation
	Echinococcosis	Veterinary public health
	Fascioliasis (foodborne trematodiases)	Veterinary public health, preventive chemotherapy
	Lymphatic filariasis (elephantiasis)	Vector (mosquito) control, preventive chemotherapy, intensified disease management
	Onchocerciasis (river blindness)	Vector (black fly) control, preventive chemotherapy
	Schistosomiasis (soil-	Preventive chemotherapy, improved hygiene and

Big Picture pg. 622 (2 of 2)

Infection Type	Disease	Management Strategies
BACTERIAL		
	Trachoma	Vector (fly) control, annual preventive deworming drugs, improved sanitation and hygiene
	Leprosy (Hansen's disease)	Preventive chemotherapy, intensified disease management
	Buruli ulcer	Vector control (if vector is discovered); preventive chemotherapy, intensified disease management, improved sanitation and hygiene
VIRAL		
	Yaws (endemic treponematosis)	Improved hygiene
	Dengue	Vector control
	Rabies	Veterinary public health

Big Picture: Neglected Tropical Diseases (2 of 2)

- WHO set NTD reduction targets for 2020
- Strategies to reduce incidence of neglected tropical diseases:
  - Preventive chemotherapy
  - Innovative, intensified disease management
  - Veterinary care
  - Vector control
  - Improved sanitation and hygiene services

Arboviral Encephalitis (1 of 3)

- Arboviruses: **ar**thropod-**bo**rne virus
  - Belong to several families
- Caused by mosquito-borne viruses
- Symptoms range from subclinical to severe
- Eastern equine encephalitis (EEE) and western equine encephalitis (WEE)
  - Thirty percent mortality in humans
  - Cause brain damage, deafness, and neurological damage

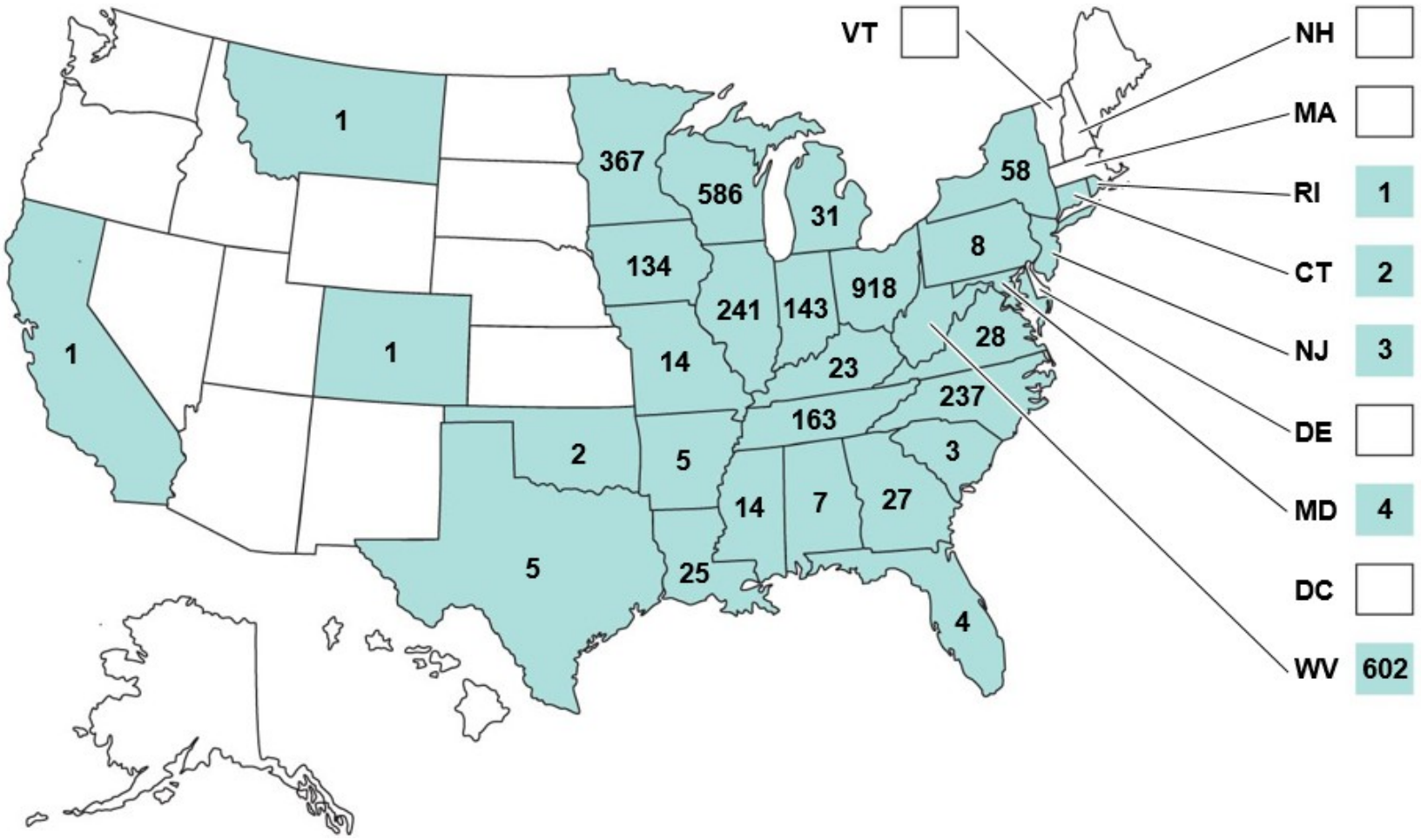
Arboviral Encephalitis (2 of 3)

- St. Louis encephalitis (SLE)
  - Distributed mostly in the central and eastern United States
  - Fewer than 1% of the infected show symptoms
- California encephalitis (CE)
  - Mild and rarely fatal
- West Nile virus (WNV)
  - Maintained in the bird-mosquito-bird cycle
  - Carried by **Culex** mosquitoes
  - Can cause poliolike paralysis and fatal encephalitis

Arboviral Encephalitis (3 of 3)

- **Japanese encephalitis**
  - Found in the Far East and South Asia
  - One percent show symptoms, but there is a 20–30% mortality in those with symptoms
- Diagnosed by ELISA tests (to identify IgM antibodies)
- Prevention: controlling mosquitoes

Figure 22.14 California Serogroup Arbovirus Cases: 1964–2010



Check Your Understanding-8

Check Your Understanding

- ✓ When there are serious local outbreaks of arboviral encephalitis, what is the usual response to minimize its transmission?
  22-11

Diseases in Focus: Types of Arboviral Encephalitis

- An 8-year-old girl in rural Wisconsin has chills, headache, and fever and reports having been bitten by mosquitoes.
- Which type of encephalitis is most likely?

Diseases in Focus 22.2 (1 of 3)

Diseases in Focus 22.2 (2 of 3)

Disease	Pathogen	Mosquito Vector	Reservoir	U.S. Distribution	Epidemiology	Mortality
Western Equine Encephalitis	WEE virus **(Togaviruses)**	**Culex**	Birds, horses		Severe disease; frequent neurological damage, especially in infants	5%
Eastern Equine Encephalitis	EEE virus **(Togaviruses)**	**Aedes, Culiseta**	Birds, horses		More severe than WEE; affects mostly young children and younger adults; relatively uncommon in humans	>30%

Diseases in Focus 22.2 (3 of 3)

Disease	Pathogen	Mosquito Vector	Reservoir	U.S. Distribution	Epidemiology	Mortality
St. Louis Encephalitis	SLE virus **(Flavivirus)**	**Culex**	Birds		Mostly urban outbreaks; affects mainly adults over 40	20%
California Encephalitis	CE virus **(Bunyavirus)**	**Aedes**	Small mammals		Affects mostly 4- to 18-year age groups in rural or suburban areas; La Crosse strain medically most important. Rarely fatal; about 10% have neurological damage	1% of those hospitalized
West Nile Encephalitis	WN virus **(Flaviviruses)**	Primarily **Culex**	Primarily birds, assorted rodents, and large mammals		Most cases asymptomatic—otherwise symptoms vary from mild to severe; likelihood of severe neurological symptoms, and	4–18% of those hospitalized

Fungal Diseases of the Nervous System

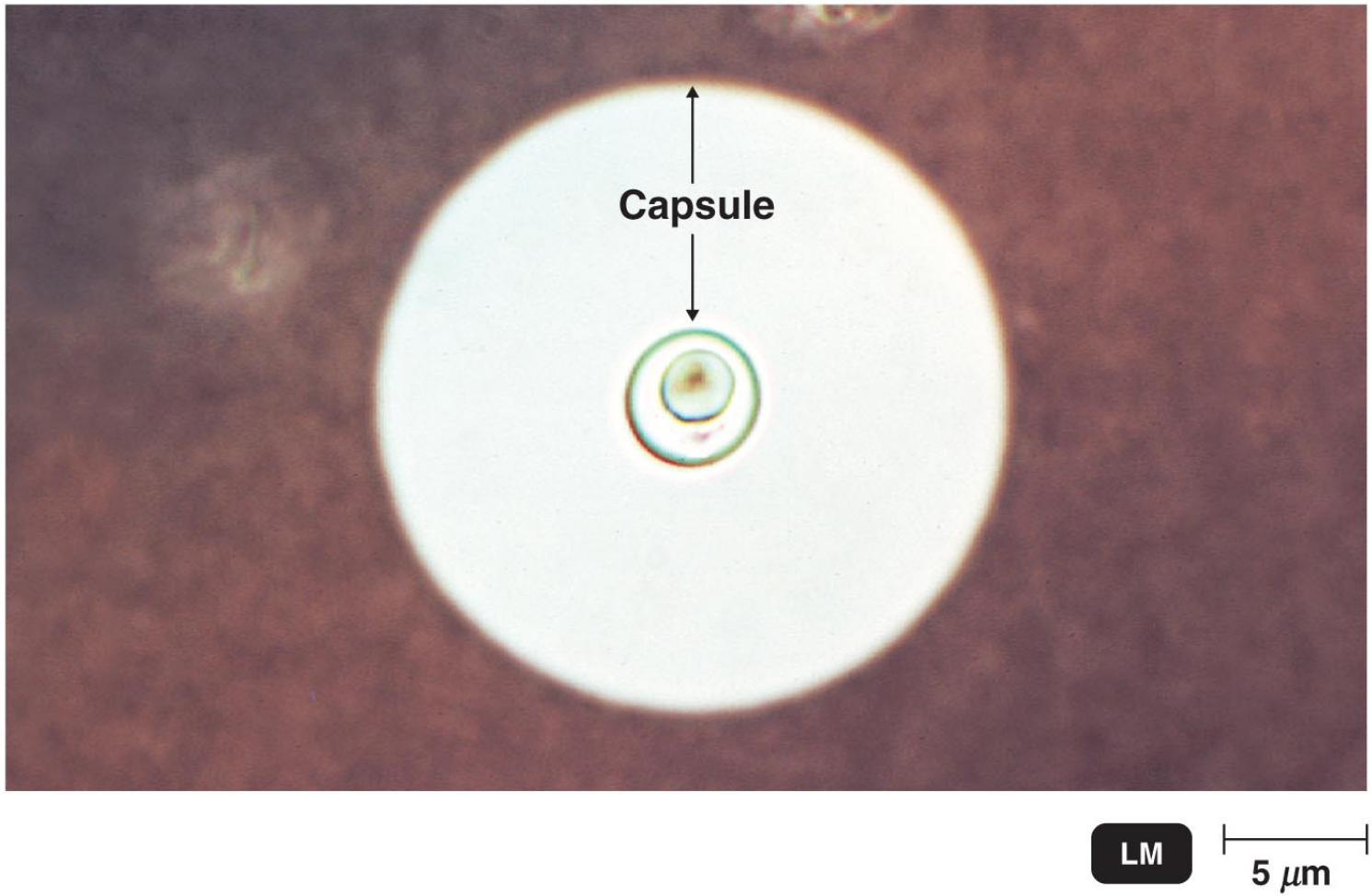
Learning Objective

22-12 Identify the causative agent, reservoir, symptoms, and treatment for cryptococcosis.

Cryptococcus Neoformans Meningitis (Cryptococcosis)

- Soil fungus associated with pigeon and chicken droppings
- Transmitted by the respiratory route through dried contaminated droppings
- In the immunocompromised, it spreads through blood to the CNS
- Mortality of up to 30%
- Treatment: amphotericin B and flucytosine

Figure 22.15 Cryptococcus Neoformans



Check Your Understanding-9

Check Your Understanding

- ✓ What is the most common source of airborne cryptococcal infections?
  22-12

Protozoan Diseases of the Nervous System

Learning Objective

22-13 Identify the causative agent, vector, symptoms, and treatment for African trypanosomiasis and amebic meningoencephalitis.

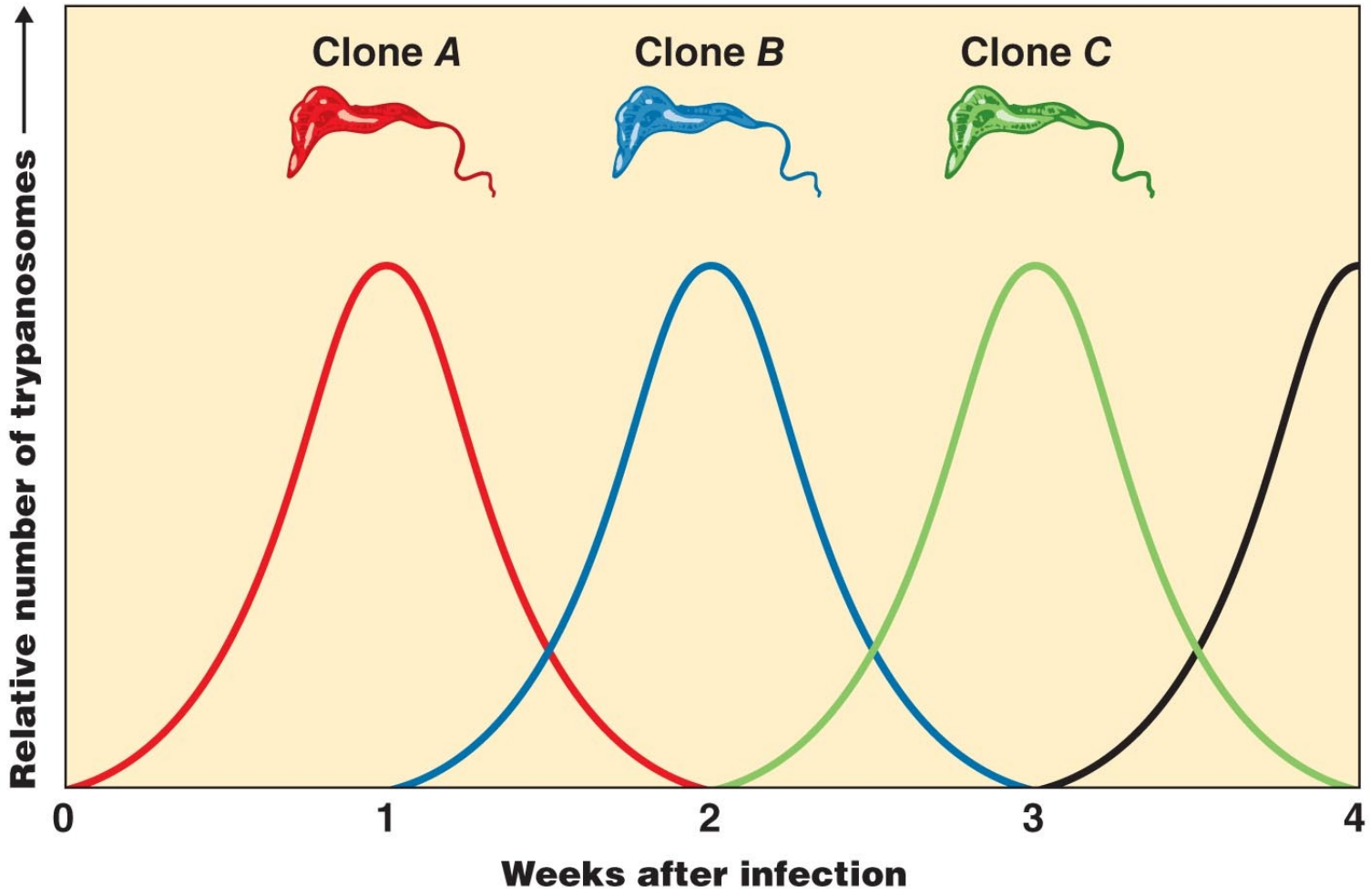
African Trypanosomiasis (1 of 2)

- **Trypanosoma brucei gambiense**
  - Humans are the only reservoir
- **T. b. rhodesiense**
  - Reservoir in livestock and wild animals
- Transmitted from animals to humans by the tsetse fly
  - Distributed in west and central Africa
- Few early symptoms, followed by fever, headache, and deterioration of the CNS

African Trypanosomiasis (2 of 2)

- Parasite evades antibodies through antigenic variation
  - Difficult for vaccine development
- Treated with eflornithine: crosses the blood–brain barrier; blocks an enzyme necessary for the parasite
- Prevention: elimination of tsetse fly vectors

Figure 22.16 How Trypanosomes Evade the Immune System



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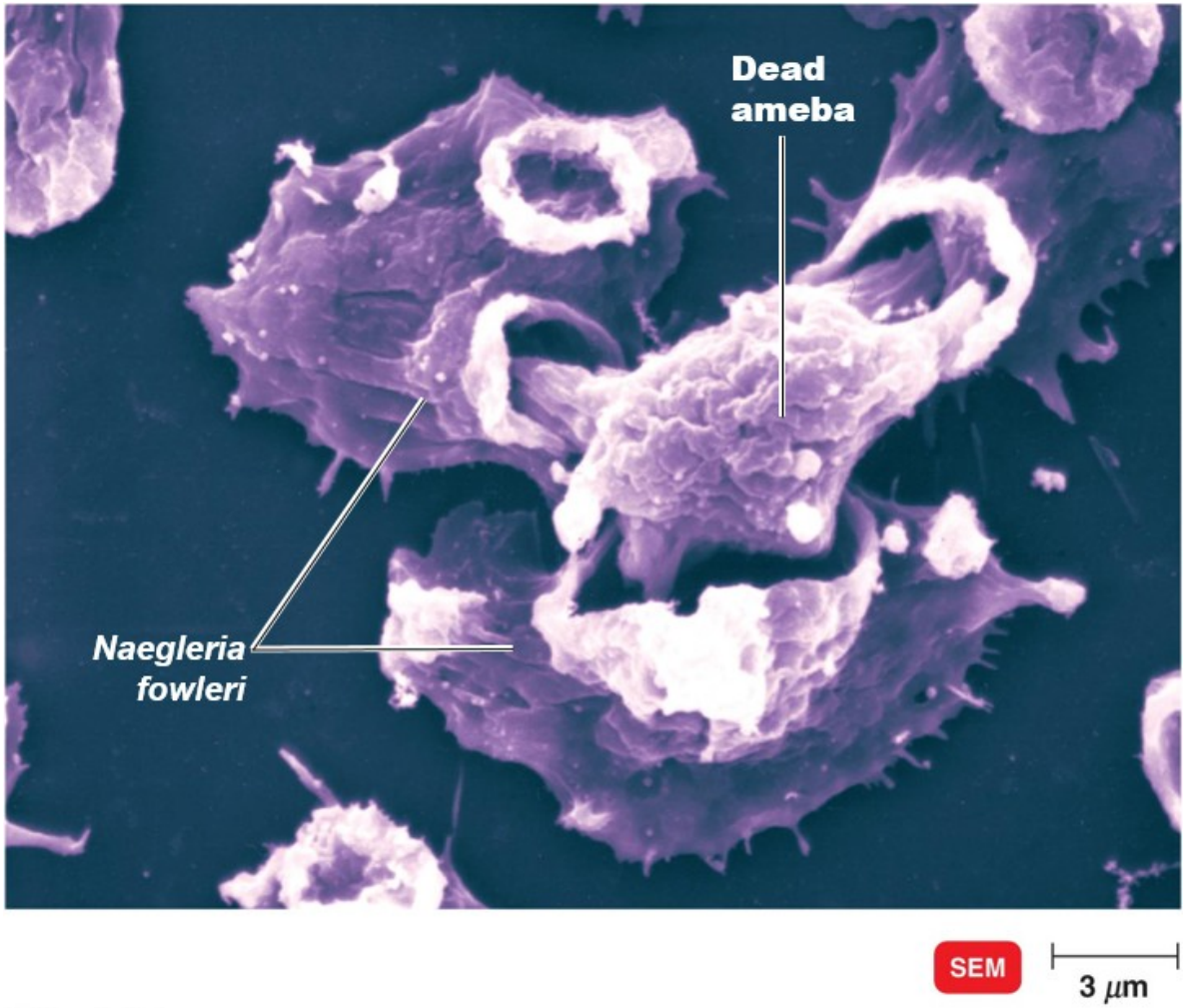
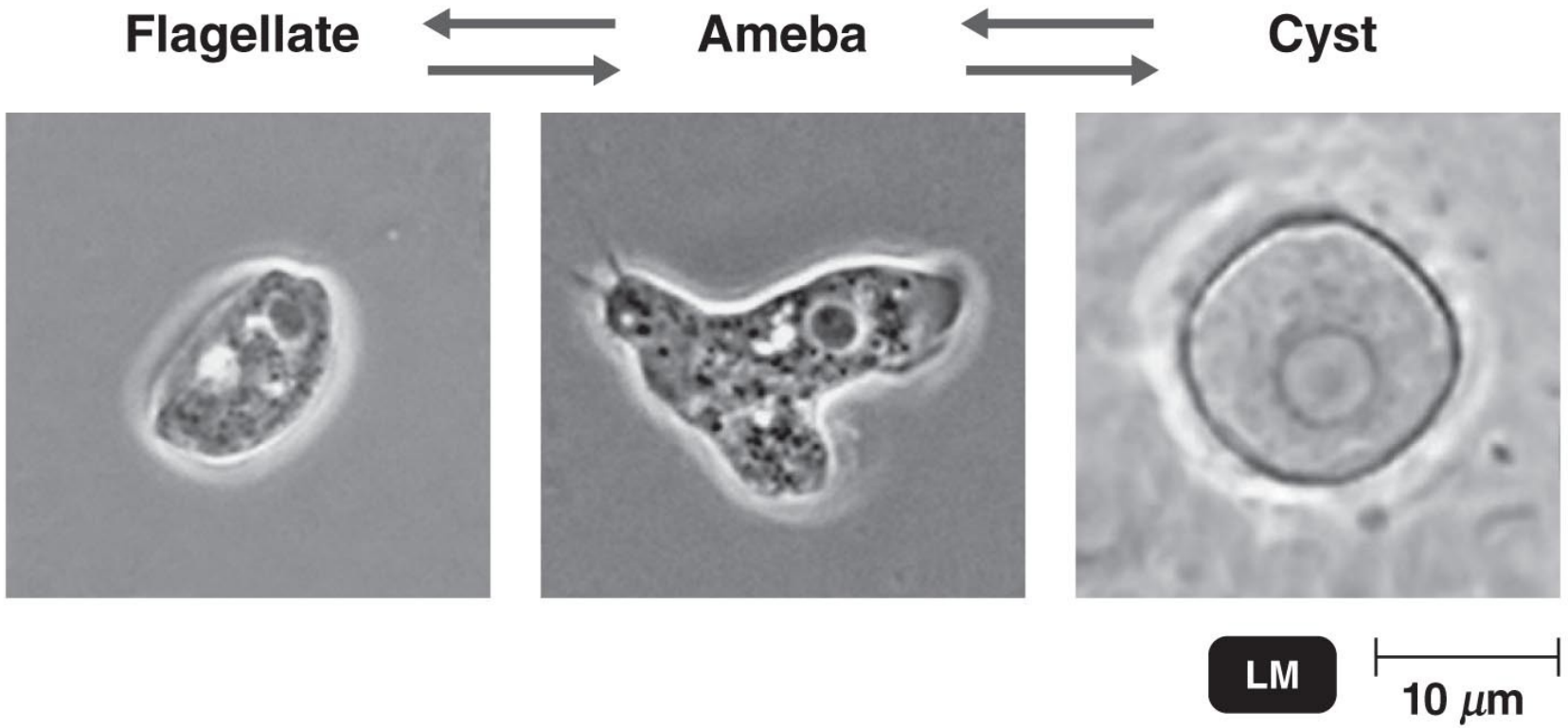
Amebic Meningoencephalitis

- **Naegleria fowleri**
  - Causes **primary amebic meningoencephalitis (PAM)**
  - Protozoan infects the nasal mucosa from swimming water, penetrates the brain, and feeds on brain tissues
  - One hundred percent fatal
- **Acanthamoeba**
  - Causes **granulomatous amebic encephalitis (GAE)**
  - Granulomas form around the site of infection, forming multiple lesions around the brain

Figure 22.17 Naegleria Fowleri



Clinical Case 22.2



Check Your Understanding-10

Check Your Understanding

- ✓ What insect is the vector for African trypanosomiasis?
  22-13

Nervous System Diseases Caused by Prions (1 of 4)

Learning Objective

22-14 List the characteristics of diseases caused by prions.

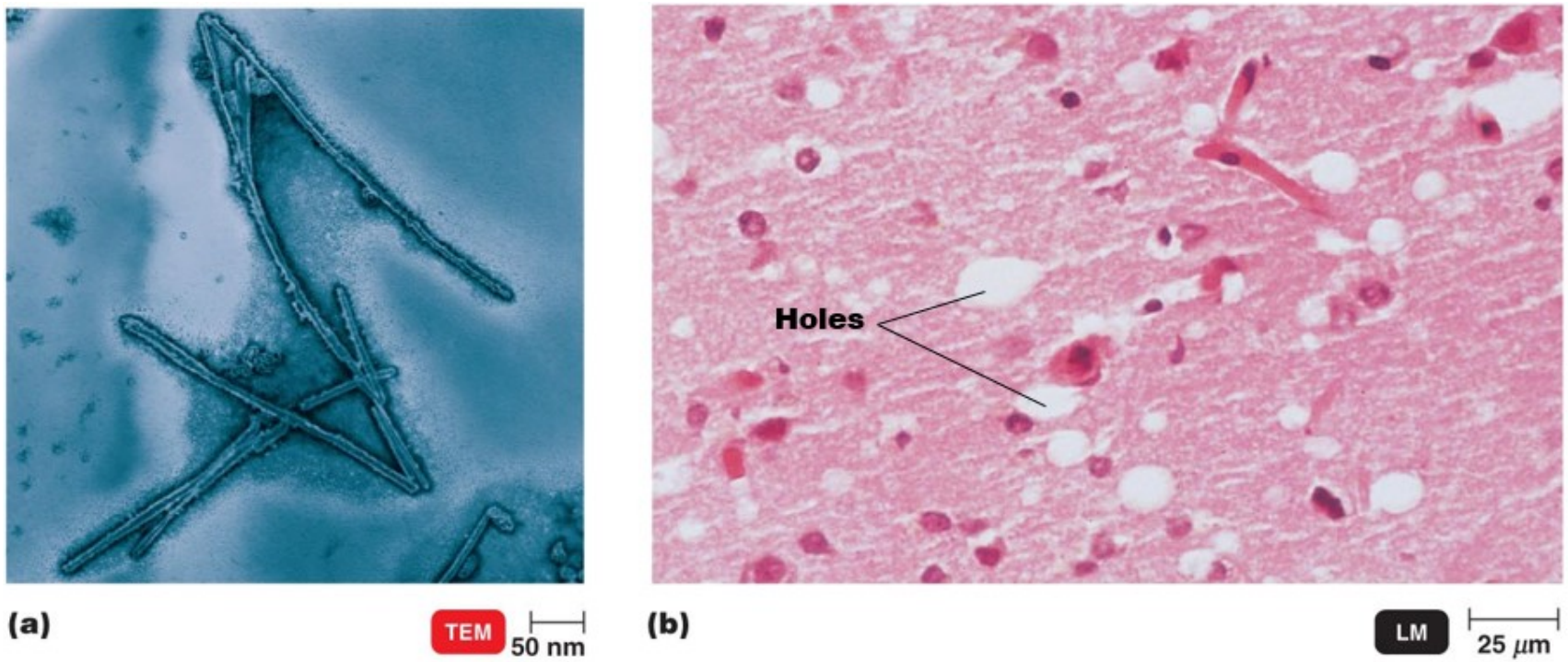
Nervous System Diseases Caused by Prions (2 of 4)

- **Prion:** abnormally folded protein
  - Causes normal proteins in the brain tissue to become abnormally folded
    - Leads to spongiform degeneration
    - Chronic and fatal
    - **Transmissable spongiform encephalopathies (TSE)**
- **Sheep scrapie**
  - TSE in sheep

Nervous System Diseases Caused by Prions (3 of 4)

- **Chronic wasting disease**
  - TSE in deer and elk
- **Creutzfeldt-Jakob disease (CJD)**
  - TSE in humans
- **Kuru**
  - TSE in humans that is caused by cannibalism
- **Bovine spongiform encephalopathy (BSE)**
  - Mad cow disease
  - Possibly due to cattle eating feed containing bone meal from scrapie-infected sheep

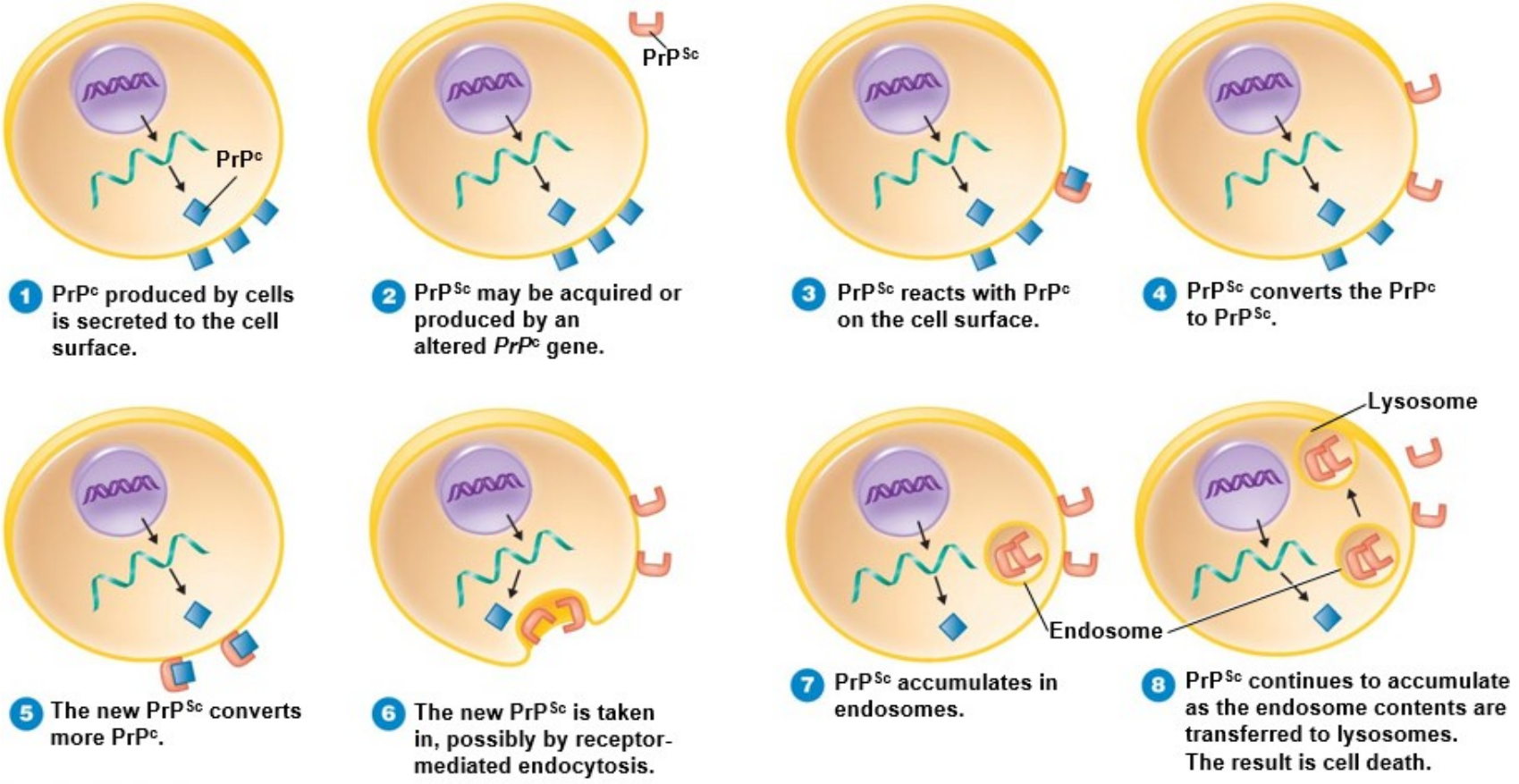
Figure 22.18 Spongiform Encephalopathies



Nervous System Diseases Caused by Prions (4 of 4)

- Variant of CJD (vCJD)
  - Occurs in younger individuals
- Some forms of CJD may be inherited
- Prions are difficult to destroy via standard methods
  - Sterilization of surgical instruments by NaOH with extended autoclaving at 134°C

Figure 13.22 How a Protein Can Be Infectious



Pearson

Check Your Understanding-11

Check Your Understanding

- ✓ What are the recommendations for sterilizing reusable surgical instruments when prion contamination might be a factor?
  22-14

Disease Caused by Unidentified Agents

Learning Objective

22-15 List some possible causes of chronic fatigue syndrome.

Chronic Fatigue Syndrome

- Also called myalgic encephalomyelitis (ME)
- Linked to the immune system and possible genetic components
- May be triggered by viral illnesses
- Diagnostic definition includes unexplained fatigue that lasts at least 6 months plus other flulike symptoms
- Found in 0.52% of women and 0.29% of men

Check Your Understanding-12

Check Your Understanding

- ✓ Name one common disease that may be associated with chronic fatigue syndrome. 22-15

Diseases in Focus: Microbial Diseases with Neurological Symptoms or Paralysis

- After eating canned chili, two children experience cranial nerve paralysis followed by descending paralysis. The children are on mechanical ventilation. Leftover canned chili is tested by mouse bioassay.
- Can you identify infections that could cause these symptoms?

Diseases in Focus 22.3 (3 of 5)

Diseases in Focus 22.3 (4 of 5)

Disease	Pathogen	Symptoms	Method of Transmission	Treatment	Prevention
BACTERIAL DISEASES					
Tetanus	**Clostridium tetani**	Lockjaw; muscle spasms	Puncture wound	Tetanus immune globulin; antibiotics	Toxoid vaccine (DTaP, Td)
Botulism	**Clostridium botulinum**	Flaccid paralysis	Foodborne intoxication	Antitoxin	Proper canning of foods; infants should not eat honey
Leprosy	**Mycobacterium leprae, M. lepromatosis**	Loss of sensation in skin; disfiguring nodules	Prolonged contact with contaminated secretions	Dapsone, rifampin, clofaximine	Possibly BCG vaccine
VIRAL DISEASES					
Poliomyelitis	Poliovirus	Headache, sore throat, stiff neck; paralysis if motor nerves infected	Ingesting Contaminated water (fecal–oral route)	Ingesting contaminated water (fecal–oral route)	Inactivated polio vaccine (IPV)
Rabies	**Lyssavirus**	Fatal infection; agitation	Animal bite	Postexposure treatment: rabies	Human diploid cell vaccine for high-

Diseases in Focus 22.3 (5 of 5)

Disease	Pathogen	Symptoms	Method of Transmission	Treatment	Prevention
PROTOZOAN DISEASE					
African Trypanosomiasis	**Trypanosoma brucei rhodesiense, T. b. gambiense**	Fatal infection; early symptoms (headache, fever) progress to coma	Tsetse fly	Suramin; pentamidine	Vector control
PRION DISEASES					
Creutzfeldt-Jakob Disease	Prion	Fatal infection; neurologic symptoms include trembling	Inherited; ingested; Transplants	None	None
Kuru	Prion	Same as Creutzfeldt-Jakob disease	Contact or ingestion	None	None